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TECHNOLOGICAL PARAMETERS OF BRIQUETTING BATCH FOR FOAM GLASS PRODUCTION

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A method for preliminary briquetting foam glass batch has been developed which not only can simplify the production process but also modify the foam glass parameters by controlling the parameters of briquette production. The parameters for preparing briquettes for foam glass based on various technological binders and the optimum binder contents are identified. It is established that denser briquettes yield foam glass of lower density.

The production of cellular glass, which is a highly efficient universal heat-insulating material, is a rather complicated energy-consuming process. The traditional technology of producing foam glass by the powder method, which consists in sintering a mixture of glass powder and a foaming agent in molds, has several disadvantages. One of them is high metal consumption; consequently, preliminary briquetting of foam glass batch makes it possible to avoid using molds.

Consolidation parameters (pressure, pressure application velocity, exposure duration) and the parameters of consolidated powder (dispersion, granulometric composition) determine the properties of briquettes and foam glass. Other significant factors in making briquettes is the choice of a technological binder and its quantity.

The purpose of this study is to identify the optimum parameters of producing briquettes for foam glass.

The material for samples, which was clear cullet, was crushed in a centrifugal-impact mill to a specific surface area of 400 m^2/kg. The advantage of this milling compared to grinding in a ball mill is getting powder of a narrow granulometric composition with particles of homogeneous shape and a high degree of defects. The foaming agent was dolomite $CaMg(CO_3)$ with a specific surface area of 250 m^2/kg.

The technological binders were aqueous solutions of sodium silicate of density 1120 kg/m^3 in the amount of 10 wt.% of dry matter and lignosulfonate (LST) in the amount of 6 wt.% of dry matter. The optimum moisture was determined based on the variation in the plastic strength of the briquette [1].

Cylindrical samples of diameter 5 cm and height 4.5 – 5.0 cm were molded by bilateral compression in a sliding mold. The briquettes were dried under normal conditions for 24 h. Swelling was carried out at a temperature of 750°C; the heating rate was 4.8 K/min. The exposure duration at the maximum temperature was 30 min.

Figure 1 shows the effect of molding pressure on the density of briquettes made with different binders. It can be seen that the density of briquettes depends only on molding pressure; the type of technological binder makes virtually no difference. However, the type of binder has a perceptible effect on the properties of foam glass. Foam glass produced from briquettes based on lignosulfonate binder has a density of 300 – 450 kg/m^3, and that based on water glass binder, 210 – 300 kg/m^3.

Thus, the introduction of water glass into a batch decreases the density of foam glass. It can be assumed that even an insignificant quantity of water glass decreases the viscosity and surface tension of the glass melt, which decreases the foam glass density. Consequently, the use of water glass is preferred for briquette production.

At the next stage of our study we determined the optimum quantity of the water-glass binder that varied from 8 to 16 wt.% of dry material. An increasing binder content in the

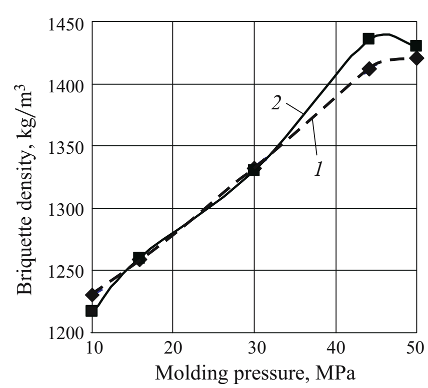

Fig. 1. The effect of the type of binder and molding pressure on density of foam-glass batch briquettes: *1*) water glass; *2*) LST.

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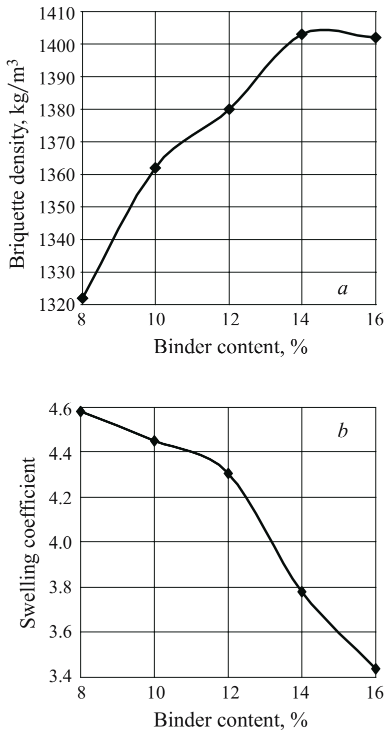

Fig. 2. The effect of the amount of water-glass binder on density of glass batch briquettes (*a*) and increase in the volume of briquette depending on the quantity of water-glass binder (*b*).

batch leads to more effective consolidation under a constant molding pressure, since it moistens and separates particles and thus decreases friction between them; however, an excess over the optimum dose of water glass decreases the density of the briquettes (Fig. 2*a*).

The effect of the quantity of binder on foam glass density was estimated based on the swelling coefficient, which was found from the following formula:

$$K_s = \frac{V_2}{V_1},$$

where V_1 and V_2 are the volumes of briquette before and after swelling, respectively.

It follows from Fig. 2*b* that the maximum swelling coefficient is achieved with a binder content equal to 8%: the briquette volume grows 4.58 times. On further increase in the quantity of binder, the swelling coefficient decreases, which can be accounted for by the coalescence of pores as a result of decreased viscosity of the glass melt.

The increased content of the binder in the briquette not only increases the density of foam glass but has also extends the duration of briquette drying. Furthermore, samples obtained from briquettes with 16% binder had cavities and cracks over their entire volume due to pressed-in air that expanded after the pressure was relieved [2].

Since the increase in the quantity of water glass binder above 10% is inadvisable, further experiments were conducted for a binder content of 8 and 10%.

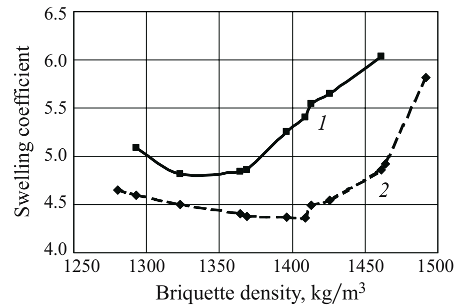

Fig. 3. The effect of the density of briquette on its volumetric increase: *1* and *2*) density of foam glass with 8 and 10% binder content, respectively.

It should be noted that denser briquettes yield foam glass of lower density (Fig. 3), since the better and more homogeneous the batch consolidation, the higher the probability of producing foam glass (other conditions being equal) of lower density and uniformly organized structure. Mechanical impacts during briquetting modify and activate the structure formation processes, facilitating the coalescence of particles and increasing the surface area of contacts between the particles; therefore, the loss of gas is significantly lower than in a freely poured batch [3].

Consequently, the higher the concentration of the solid phase in the initial material, the more intense is the foaming process. Furthermore, preliminary consolidation of the batch in a mold in foam glass production makes it possible to form a layer with a uniform volumetric porosity and a smaller initial pore size, which contributes to more uniform pororizing of the layer under heating and intensifies the batch sintering under heating [4]. The process of pore formation depends on the thermophysical properties of the batch, primarily on its thermal conductivity, which significantly grows under consolidation [3]. The thermal conductivity of the obtained briquettes of density $1300\ \text{kg/m}^3$ is equal to $0.56\ \text{W/(m}\cdot\text{K)}$ and in briquettes of density $1500\ \text{kg/m}^3$, $0.67\ \text{W/(m}\cdot\text{K)}$.

Thus, preliminary briquetting of foam glass batch not only simplifies the production process but makes it possible to modify the characteristics of the foam glass by controlling the parameters of briquette formation.

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